

Cuntz, M., Rossi, P., Ulmschneider, P.: 2001, "Properties of longitudinal flux tube waves. II. Limiting shock strength behavior", Astronomy and Astrophysics, submitted

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**HIGH ENERGY PLASMA SPACE PROPULSION**

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In order to meet NASA's challenge on Advanced concept activity in the propulsion area, we initiated a new program entitled "High Energy Plasma Space Propulsion Studies" within the current cooperative agreement in 1998. The goals of this work are to gain further understanding of the engine of the AIMStar spacecraft, a concept which was developed at Penn State University (1), and to develop a prototype concept for the engine.

The AIMStar engine concept was developed at Penn State University several years ago as a hybrid between antimatter and fusion technologies. Because of limited amounts of antimatter available, and concurrently the demonstrated ability for antiprotons to efficiently ignite nuclear fusion reactions, it was felt that this was a very good match.

Investigations have been made concerning the performance of the reaction trap. This is a small Penning-like electromagnetic trap, which is used to simultaneously confine antiprotons and fusion fuels. Small DHe3 or DT droplets, containing a few percent molar of a fissile material, are injected into the trap, filled with antiprotons. We have found that it is important to separate the antiprotons into two adjacent wells, to inject the droplet between them and to simultaneously bring the antiprotons to the center of the trap, surrounding the droplet. Our previous concept had the droplet falling onto one cloud of antiprotons. This proved to be inefficient, as the droplet tended to evaporate away from the cloud as it interacted on its surface.

We have found that the most efficient method of constructing the droplet is to build a very thin shell of fissile material, with thickness of perhaps 10 microns, and to fill the shell with a cryogenically prepared mixture of DHe3 or DT. The outside diameter of the droplet is about 50 microns. The antiprotons interact with the fissile shell, and one of the two fission fragments injects itself into the fusion fuel. We find that  $10^{10}$  antiprotons interacting uniformly over the surface of the droplet can raise the temperature of the droplet to about 10 eV. This temperature is

far from that required to ignite fusion, but sufficient to demonstrate the formation of a hot plasma.

Given the long and arduous history of nuclear fusion research, we expect that the pathway to a demonstrated fusion technology for space applications will involve a series of ever-increasing (in size) and sophisticated experiments. The first such experiment would be to expose a small number of droplets in a prototype reaction trap to antiprotons confined in the High Performance Antimatter Trap (HiPAT), currently under development at the Marshall Space Flight Center (MSFC). HiPAT is designed to hold a maximum of  $10^{12}$  antiprotons.

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## GAMMA RAY ASTRONOMY

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The members of this discipline are almost equally divided between UAH and USRA in collaboration with the NASA/MSFC Physics and Astronomy Division. Dr. William Paciesas UAH is team leader for this group's effort. See the USRA Report for Gamma Ray USRA activities. The project has progressed successfully during this period of performance. The highlights of the Gamma Ray Astronomy teams efforts are: (a) Support daily BATSE data operations, including receipt, archival and dissemination of data, quick-look science analysis, rapid gamma-ray burst and transient monitoring and response efforts, instrument state-of-health monitoring, and instrument commanding and configuration; (b) On-going scientific analysis, including production and maintenance of gamma-ray burst, pulsed source and occultation source catalogs, gamma-ray burst spectroscopy, studies of the properties of pulsars and black holes, and long-term monitoring of hard x-ray sources; (c) Maintenance and continuous improvement of BATSE instrument response and calibration data bases; (d) Investigation of the use of solid state detectors for eventual application and instrument to perform all sky monitoring of X-Ray and Gamma sources with high sensitivity; (e) Support of BATSE outreach activities, including seminars, colloquia and World Wide Web pages. The highlights of this efforts can be summarized in the following publications and presentation list.

### Publications and Presentations

M. S. Briggs, W. S. Paciesas, G. N. Pendleton, C. A. Meegan, G. J. Fishman, J. M. Horack, M. N. Brock, C. Kouveliotou, D. H. Hartmann and J. Hakkila, "BATSE Observations of the Large-Scale Isotropy of Gamma-Ray Bursts," *Astrophys. J.*, 459, 40-63 (1996).

I. G. Mitrofanov, A. M. Chernenko, A. S. Pozanenko, M. S. Briggs, W. S. Paciesas, G. J. Fishman, C. A. Meegan and R. Z. Sagdeev, "The Average Intensity and Spectral Evolution of the BATSE Cosmic Gamma-Ray Bursts," *Astrophys. J.*, 459, 570-578 (1996).

B. C. Rubin, M. H. Finger, B. A. Harmon, W. S. Paciesas, G. J. Fishman, R. B. Wilson, C. A. Wilson, M. N. Brock, M. S. Briggs, G. N. Pendleton, L. R. Cominsky and M. S. Roberts, "Observations of 4U 1700-37 with BATSE," *Astrophys. J.* 459, 259-270 (1996).

D. L. Band, S. Ryder, L. A. Ford, J. L. Matteson, D. M. Palmer, B. J. Teegarden, M. S. Briggs, W. S. Paciesas, G. N. Pendleton and R. D. Preece, "BATSE Gamma-Ray Burst Line Search. IV. Line Candidates from the Visual Search," *Astrophys. J.*, 458, 746-754 (1996).